



Docket No. 02-1166

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

APPEAL NO. \_\_\_\_\_

First named inventor:  
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Art Unit: 3682

Title: LOW ANGLE INTERSECTING AND SKEW FACE GEAR

**APPEAL BRIEF**

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### **1. REAL PARTY IN INTEREST**

The real party in interest is the assignee, The Boeing Company.

### **2. RELATED APPEALS AND INTERFERENCES**

No appeals or interferences are known to have a bearing on the Board's decision in the pending appeal.

### **3. STATUS OF CLAIMS**

Claims 1-6 and 11-13 are cancelled.

Claims 7-10 and 14-16 are pending.

Claims 7-10 and 14-16 are rejected.

The rejections of claims 7-10 and 14-16 are being appealed.

### **4. STATUS OF AMENDMENTS**

An after final amendment was filed on 12 April 2010, subsequent to the final rejection dated 18 December 2009. The after final amendment included a replacement sheet 2/2 for overcoming an objection to the drawings. The after final amendment was entered and the objection was withdrawn.

## **5. SUMMARY OF CLAIMED SUBJECT MATTER**

### **Claim 7**

Base claim 7 recites a machine. An example of the machine is illustrated in Figure 5. The machine comprises a first shaft 70, a spur gear 62 mounted to the first shaft 70, a second shaft 72, and a face gear 20 including a hub mounted to the second shaft 72 (page 4, lines 12-18). The first and second shafts have an angular variance greater than zero degrees (page 4, lines 14-16). As shown in Figures 1-3, an angled gear flange 30 surrounds the hub 24, and a plurality of gear teeth 32 are on the gear flange 30 (page 3, lines 15-24). The face gear 20 is in mesh with the spur gear 62 (page 4, lines 16-17).

As shown in Figure 4, a first vector  $N_g$  normal to an outside surface of the angular flange 30 and a second vector  $V_p$  normal to the second shaft 72 form an angle that is equal to the angular variance 48 of the first and second shafts 70 and 72 (page 4, lines 4-11). The so-called criticality here is that by angling the gear flange 30 at the angle recited in claim 7, the face gear 20 can achieve line contact with the spur gear 62 (page 4, lines 25-26). This overcomes a problem with cross axis helical gears on shafts having a small angular variance. The helical gears make contact at a point and thus take the full load of the gear (page 1, lines 25-26). Because the point takes the full load of the gear, the gear is made larger and heavier to handle the full load.

### **Claim 10**

Claim 10 depends indirectly from claim 7. Claim 10 recites the machine of claim 7, further comprising an engine for driving the first shaft 70 and a transmission driven by the second shaft 72 (page 4, line 14), wherein the engine

and transmission are a rotary aircraft engine and transmission (page 4, lines 14-16).

Claim 15

Base claim 15 recites an assembly. An example of the assembly is illustrated in Figure 5. The assembly comprises first and second shafts 70 and 72 that are non-parallel, a spur gear 62 on the first shaft 70; and a face gear 20 on the second shaft 72 (page 4, lines 12-18). The face and spur gears 20 and 62 are in constant mesh (page 4, lines 16-17). The face gear 20 includes a hub 24 on the second shaft 72, an angled flange 30 around the hub 24, and gear teeth 32 on the angled flange 30 (Figures 1-3 and page 3, lines 15-24). The flange 30 is angled so the face gear 20 achieves line contact with the spur gear 62 when the gears are in mesh (page 4, lines 25-26).

Claim 16

Claim 16 recites the assembly of claim 15, wherein the first and second shafts 70 and 72 have an angular variance of no more than 30 degrees (Figure 5 and page 3, lines 13-14).

**6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL**

a. Rejection of claims 7, 9 and 15 under 35 USC §102(b) as being anticipated by Ovshinsky U.S. Patent No. 2,967,980.

b. Rejection of claims 7-9 and 14-16 under 35 USC §103(a) as being unpatentable over Yokel U.S. Patent No. 3,803,934 in view of Ovshinsky U.S. Patent No. 2,967,980.

c. Rejection of claim 10 under 35 USC §103(a) as being unpatentable over Stone U.S. Patent No. 3,942,387 in view of Ovshinsky U.S. Patent No. 2,967,980.

## **7. ARGUMENTS**

All pending claims recite a face gear. A face gear is a term of art. It is a different type of gear than a spur gear or a bevel gear or a helical gear. The Appendix section includes a copy of a web page from

[http://www.engineersedge.com/gears/gear\\_types.htm](http://www.engineersedge.com/gears/gear_types.htm)

which describes and differentiates face gears, spur gears, bevel gears and helical gears. The copy of the web page was made of record as part of the response filed on 26 Jan. 2009. It is provided in Appendix IX.

Ovshinsky U.S. Patent No. 2,967,980 is made of record. Ovshinsky also differentiates face gears from bevel gears. For instance, compare face gear 122 in Figure 8 (column 7, lines 31-33) to bevel gear 306/310/312 in Figure 10 (column 8, lines 72-73). The bevel gear has a sleeve 306 with an annular flange 310 normal to the sleeve 306, and inclined bevel teeth 312 at a perimeter of the flange 310. The face gear 122 has a hub, a flange normal to the hub, and teeth normal to a surface of the flange.

I

### **REJECTION OF CLAIMS 7, 9 AND 15 UNDER 35 USC §102(B) AS BEING ANTICIPATED BY OVSHINSKY U.S. PATENT NO. 2,967,980**

The '102 rejection contains factual deficiencies. Ovshinsky does not describe a face gear that meshes with a spur gear. Ovshinsky does not describe a face gear having an angled flange, let alone a flange having all of the features recited in base claims 7 and 15.

Ovshinsky discloses a power steering mechanism for a vehicle. Figures 10-11 and col. 8, lines 58-75 describe a steering wheel having upper and lower sections 300 and 302. A sleeve 306 is connected to the lower section 302, an

annular flange 310 surrounds the sleeve 306, and bevel teeth 312 are formed at a periphery of the flange 310. The bevel teeth 312 engage a pinion gear 314 at the end of a power output shaft 304.

The office action alleges that element 306/310/312 is a face gear, but Ovshinsky does not support the allegation. Ovshinsky describes element 306/310/312 as a bevel gear (col. 8, lines 72-73).

Moreover, the element 306/310/312 does not have a first vector normal to an outside surface of an angular flange 310 and a second vector normal to the shaft section 302 to form an angle that is equal to the angular variance of the first and second shaft sections 302 and 304. Ovshinsky is silent about these vectors.

Ovshinsky does show a face gear 122 in Figure 8. The face gear 122 is fixed to a transfer shaft 124 (column 7, lines 31-33), and engages pinions 118 and 120, which are fixed to a drive shaft 98 (column 7, lines 26-30 and 59-61).

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

#### **Claims 7 and 9**

Ovshinsky does not describe any modifications to a standard face gear. Ovshinsky is silent about the face gear 122 having an angled flange. In any event, Ovshinsky is silent about the face gear 122 having a first vector normal to an outside surface of its angular flange and a second vector normal to the transfer shaft 124 wherein the vectors form an angle that is equal to the angular variance of the drive and transfer shafts 98 and 124. Thus, Ovshinsky does not describe



each and every feature recited in base claim 7. Therefore, the '102 rejection of claims 7 and 9 should be withdrawn.

**Claim 15**

Ovshinsky is silent about the face gear 122 having an angled flange, wherein the flange is angled so the face gear 122 achieves line contact with the gears 118 and 120 when the gears are in mesh. Thus, Ovshinsky does not describe each and every feature recited in base claim 15. Therefore, the '102 rejection of claim 15 should be withdrawn.

**II**

**REJECTION OF CLAIMS 7-9 AND 14-16 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER YOKEL U.S. PATENT NO. 3,803,934 IN VIEW OF OVSHINSKY U.S. PATENT NO. 2,967,980**

The key to supporting any rejection under 35 U.S.C. §103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in KSR International Co. v. Teleflex Inc. noted that the analysis supporting a rejection under 35 U.S.C. §103 should be made explicit. "Rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness" (citations omitted).

Yokel discloses a transmission that transmits power to an inclined propeller shaft 4. The transmission includes a bevel gear 18 that is journaled on an input shaft 10. The bevel gear 18 is of the tapered helical type, having a front end of smaller diameter [than its back end] (column 3, lines 57+). The transmission further includes an output shaft 40, which is inclined at approximately 7 degrees of

horizontal. A large tapered helical gear 44 on the output shaft 40 is in constant mesh with the bevel gear 18 (column 3, lines 26+).

Yokel does not disclose face gears. Yokel proposes two tapered helical gears that are in constant mesh to transmit power between non-parallel shafts 10 and 40.

Ovshinsky does not teach or suggest using a face gear in place of Yokel's helical gears. As discussed in Argument I, Ovshinsky does not teach or suggest a face gear having an angled flange. Moreover, Ovshinsky does not teach or suggest the use of a face gear to transmit power between shafts that are inclined (such as Yokel's shafts 10 and 40). Ovshinsky teaches the use of bevel gears to transmit motion between shafts that are inclined (e.g., shafts 302 and 304).

#### **Claims 7-9 and 14**

Therefore, the combined teachings of Yokel and Ovshinsky do not produce a machine having all of the features recited in base claim 7. Specifically, there is no teaching or suggestion in either patent to use a face gear having an angled flange to transmit power between inclined shafts. More specifically, there is no teaching or suggestion in either patent to use a face gear having an angled flange, wherein a first vector normal to an outside surface of the flange and a second vector normal to the second shaft form an angle that is equal to the angular variance of the inclined shafts.

Ovshinsky teaches the use of bevel gears to transmit motion between shafts that are inclined. Yokel teaches the use of bevel and helical gears.

Thus, the office action omits elements necessary for establishing prima face obviousness of base claim 7. Due to this factual deficiency, the '103 rejection of claims 7-9 and 14 should be withdrawn.

The '103 rejection of claims 7-9 and 14 also contains legal deficiencies. The '103 rejection does not comply with KSR because the final office action does not provide articulated reasoning to support obviousness. It does not provide any reasons for replacing Yokel's helical gears with Ovshinsky's bevel gears.

The office action merely provides a bald conclusion of obviousness. Page 7 concludes that it would be "obvious ... to substitute gear pairs to achieve the predictable result of transmitting motion on angled shafts." Yet it provides no evidence to suggest that the results would be predictable. For instance, it does not consider that Yokel's assembly has different operational and structural requirements than Ovshinsky's assembly (turning a propeller versus turning a steering column). Due to this legal deficiency, the '103 rejection of claims 7-9 and 14 should be withdrawn.

#### **Claim 15**

There is no teaching or suggestion in either patent to use a face gear having an angled flange to transmit power between inclined first and second shafts. More specifically, there is no teaching or suggestion in either patent to use a face gear including a hub on the second shaft, an angled flange around the hub, and gear teeth on the angled flange, the flange angled so the face gear achieves line contact with a spur gear on the first shaft when the gears are in mesh. Thus, the office action omits elements necessary for establishing prima facie obviousness of base claim 15. Due to this factual deficiency, the '103 rejection of base claim 15 should be withdrawn.

The '103 rejection of base claim 15 also contains legal deficiencies. The '103 rejection does not comply with KSR for the reasons above.

**Claim 16**

Claim 16, which depends from claim 15, recites that the first and second shafts have an angular variance of no more than 30 degrees. Thus, claim 16 recites the use of a face gear having a flange that is angled so the face gear on the second shaft achieves line contact with the spur gear on the first shaft when the gears are in mesh.

The angular variance between Ovshinsky's drive and transfer shafts 98 and 124 is 90 degrees. Ovshinsky does not teach or suggest the use of a face gear for an angular variance other than 90 degrees. Rather, as discussed in Argument 1, Ovshinsky teaches the use of a bevel gear 306/310/312 and pinion 314 to transmit power between shafts (302 and 304) angled at no more than 30 degrees.

Therefore, the final office action provides no rational underpinnings to support its conclusion of obviousness of claim 16. Due to these additional legal and factual deficiencies, the '103 rejection of claim 16 should be withdrawn.

### III

#### **REJECTION OF CLAIM 10 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER STONE U.S. PATENT NO. 3,942,387 IN VIEW OF OVSHINSKY U.S. PATENT NO. 2,967,980**

Stone discloses a helicopter transmission including a power input shaft 12 that carries a beveled pinion 18, and an angled power output shaft 32 that carries a bevel gear 30 (col. 2, lines 11-38). The bevel gear 30 meshes with the pinion 18. Stone is concerned about gaining access to critical units in a gearbox (col. 1, lines 19-28), not point contact of the gears 18 and 30.

Page 8 of the office action alleges that gear 30 is a face gear and that gear 18 is a spur gear. However, Stone does not support the allegation. Stone clearly discloses that gear 30 is a bevel gear, and gear 18 is a beveled pinion (col. 2, lines 37-38).

Ovshinsky also discloses bevel gears for transmitting power between non-parallel shaft sections 302 and 304. Ovshinsky does not teach or suggest using face and spur gears in place of Stone's bevel gear 30 and pinion 18.

Thus, the machine produced by the combined teachings of Stone and Ovshinsky would not include a face gear, let alone the claimed face gear. Because the office action omits elements necessary to establish prima facie obviousness of claim 10, the '103 rejection of claim 10 should be withdrawn.

The '103 rejection of claim 10 also contains legal deficiencies because it does not comply with KSR. The office action merely provides a bald conclusion of obviousness. Page 9 concludes that it would be "obvious ... to substitute gear pairs to achieve the predictable result of transmitting motion on angled shafts." Yet it provides no evidence to suggest that the results would be predictable. Ovshinsky's bevel and pinion gears are designed for a different purpose than the

bevel and pinion gears 30 and 18 of Stone (turning a steering column versus rotating a helicopter blade). Ovshinsky's bevel gear 306/310/312 is designed for far, far lower loads and speeds than Stone's helicopter transmission. Point contact between bevel and pinion gears might not be a problem with turning a steering column. As for rotating a helicopter blade, Stone is silent about point contact between gears. So is Ovshinsky. Thus, neither Stone nor Ovshinsky provides underpinnings for replacing Stones gears 30 and 18 with the claimed face gear and a spur gear. Due to this additional legal deficiency, the '103 rejection of claim 10 should be withdrawn.

The only discussion about point contact is provided by the applicant. Only the applicant describes an approach that overcomes the problem of point contact in power transmissions such as helicopter transmission. That approach is clearly recited in claim 10.

For the reasons above, the rejections should be reversed. The Honorable Board of Patent Appeals and Interferences is respectfully requested to reverse the rejections.

Respectfully submitted,

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Date: August 19, 2010

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Reg. No. 33,890

## **8. CLAIMS APPENDIX**

1-6. (Cancelled)

7. (Previously presented) A machine comprising:

a first shaft;

a spur gear mounted to the first shaft;

a second shaft, the first and second shafts having an angular variance greater than zero degrees; and

a face gear including a hub mounted to the second shaft, an angled gear flange surrounding the hub, and a plurality of gear teeth on the gear flange, the face gear in mesh with the spur gear,

wherein a first vector normal to an outside surface of the angular flange and a second vector normal to the second shaft form an angle that is equal to the angular variance of the first and second shafts.

8. (Previously presented) The machine of Claim 7, further comprising an engine for driving the first shaft and a transmission driven by the second shaft.

9. (Previously presented) The machine of Claim 7, wherein the gear teeth of the face gear are formed by a precision grinding method.



10. (Previously presented) The machine of Claim 8, wherein the engine and transmission are a rotary aircraft engine and transmission.

11-13. (Cancelled)

14. (Previously presented) The machine of claim 7, wherein the first and second shafts have an angular variance of no more than 30 degrees.

15. (Previously presented) An assembly comprising:

first and second shafts that are non-parallel;

a spur gear on the first shaft; and

a face gear on the second shaft, the face and spur gears in constant mesh, the face gear including a hub on the second shaft, an angled flange around the hub, and gear teeth on the angled flange, the flange angled so the face gear achieves line contact with the spur gear when the gears are in mesh.

16. (Previously presented) The assembly of claim 15, wherein the first and second shafts have an angular variance of no more than 30 degrees.

## **9. EVIDENCE APPENDIX**

**Gear Types, Spur, Helical, Bevel, Rack and Pinion, Worm**

[Gear Products and Suppliers](#) | [Gear Knowledge Menu](#)

### **Spur Gears:**

Spur gears are the most common type used. Tooth contact is primarily rolling, with sliding occurring during engagement and disengagement. Some noise is normal, but it may become objectionable at high speeds.



### **Rack and Pinion.**

Rack and pinion gears are essentially a linear shaped variation of spur gears. The spur rack is a portion of a spur gear with an infinite radius.



### **Internal Ring Gear:**

Internal gear is a cylindrical shaped gear with the meshing teeth inside or outside a circular ring. Often used with a spur gear. Internal ring gears may be used within a planetary gear arrangement.



### **Helical Gear:**

Helical gear is a cylindrical shaped gear with helicoid teeth. Helical gears operate with less noise and vibration than spur gears. At any time, the load on helical gears is distributed over several teeth, resulting in reduced wear. Due to their angular cut, teeth meshing results in thrust loads along the gear shaft. This action requires thrust bearings to absorb the thrust load and maintain gear alignment. They are widely used in industry. A negative is the axial thrust force the helix form causes.



### **Helical Rack Gear:**

Helical rack gears are linear shaped and meshes with a rotating helical gear.



**Double Helical Gear:**

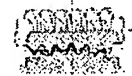
Double helical gear may have both left-hand and right-hand helical teeth. The double helical form is used to balance the thrust forces and provide additional gear shear area.

**Face Gear:**

Face gears are a circular disc with a ring of teeth cut on one side. The gear teeth are tapered toward the center of the tooth. These gears typically mate with a spur gear.

**Worm Gear:**

Worm gears teeth resembles ACME screw thread which mates with a helical gear, except that it is made to envelope the worm as seen along the worm's axis. Operation of worm gears is analogous to a screw. The relative motion between these gears is sliding rather than rolling. The uniform distribution of tooth pressures on these gears enables use of metals with inherently low coefficients of friction such as bronze wheel gears with hardened steel worm gears. These gears rely on full fluid film lubrication and require heavy oil compounded to enhance lubricity and film strength to prevent metal contact.

**Double Enveloping Worm Gear:**

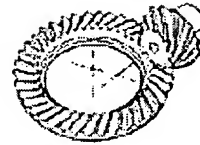
The double enveloping worm gear has a radial changing pitch diameter. This increases

the number and amount of tooth shear area.



#### **Hypoid Gear:**

Hypoid gears are typically found within the differential (rear axle) of automobiles. The gear arrangement allows the translation of torque ninety degrees. Hypoid gears are similar to spiral bevel gears except that the shaft center lines do not intersect. Hypoid gears combine the rolling action and high tooth pressure of spiral bevels with the sliding action of worm gears. This combination and the all-steel construction of the drive and driven gear result in a gear set with special lubrication requirements, including oiliness and anti-weld additives to withstand the high tooth pressures and high rubbing speeds.



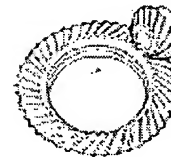
#### **Straight Bevel Gear:**

Straight bevel gears have tapered conical teeth which intersect the same tooth geometry. Bevel gears are used to transmit motion between shafts with intersecting center lines. The intersecting angle is normally 90 deg but may be as high as 180 deg. When the mating gears are equal in size and the shafts are positioned at 90 degrees to each other, they are referred to as miter gears. The teeth of bevel gears can also be cut in a curved manner to produce spiral bevel gears, which produce smoother and quieter operation than straight cut bevels.



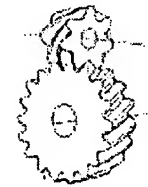
#### **Spiral Bevel Gear:**

Spiral bevel gears have a helical angle spiral teeth.



#### **Screw Gear (Crossed Helical Gear):**

Screw gears are helical gears of opposite helix angle will mesh when their axes are crossed.



**10. RELATED PROCEEDINGS APPENDIX**

None